PATENT APPLICATION

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

In re application of

Docket No: Q53818

Takayuki KIFUKU

Appln. No.: 09/286,418

Group Art Unit: 3661

Confirmation No.: 4951

Examiner: Brian J. Broadhead

Filed: April 06, 1999

For: ELECTRIC POWER STEERING SYSTEM

SUBMISSION OF APPELLANT'S BRIEF ON APPEAL

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Submitted herewith please find an original and two copies of Appellant's Brief on Appeal. A check for the statutory fee of $320.00 is attached. The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account. A duplicate copy of this paper is attached.

Respectfully submitted,

Cameron W. Beddard
Registration No. 46,545

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860
WASHINGTON OFFICE
23373
PATENT TRADEMARK OFFICE

Date: June 2, 2003

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APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. § 1.192

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Alexandria, VA 22313-1450

Sir:

In accordance with the provisions of 37 C.F.R. § 1.192, Appellant submits the following:

I. REAL PARTY IN INTEREST

The real party in interest is MITSUBISHI DENKI KABUSHIKI KAISHA, by virtue of an assignment executed by Takayuki Kifuku (Appellant, hereafter) on March 19, 1999, and recorded by the Assignment Branch of the U.S. Patent and Trademark Office on April 6, 1999, at Reel 9889, Frame 0516.

II. RELATED APPEALS AND INTERFERENCES

To the knowledge and belief of Appellant, the Assignee, and the undersigned, there are no other appeals or interferences before the Board of Appeals and Interferences that will directly affect or be affected by the Board's decision in the instant Appeal.

III. STATUS OF CLAIMS

Claims 1, 2, and 4-20 are all the claims pending in the application. Claims 1, 2, and 4-20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kifuku et al. (US 5,740,040) in view of Setaka et al. (US 4,881,414).

The appealed claims are claims 1, 2, and 4-20.

IV. STATUS OF AMENDMENTS

All amendments have been entered.

V. SUMMARY OF THE INVENTION

The present invention relates to an electric power steering system for assisting steering force with a motor. FIG. 1 is a diagram showing an electric power steering system according to an illustrative embodiment of the present invention. The electric power steering system of FIG. 1 includes a motor 1, a steering wheel 11, a steering shaft 12 connected to the steering wheel 11, a car speed sensor 13 for detecting the speed of an automobile by detecting the rotation of a transmission (not shown), a torque sensor 14 connected to the steering shaft 12 for detecting the steering torque of a driver, a motor reduction gear 15 for transmitting the output torque of the

motor 1 to the steering shaft 12, a controller 16 for driving and controlling the motor 1 based on signals from the car speed sensor 13, the torque sensor 14 and the like, and a battery 17 as a power source for the controller 16. See page 11, lines 4-18, of the present specification.

FIG. 3 is a diagram showing an illustrative embodiment of the software stored in a ROM 31 (FIG. 2) used for steering control, and FIG. 4 is a flow chart for explaining the operation of the software. FIG. 3 includes a motor 1, motor angular velocity computing means 2, motor angular acceleration computing means 3, coulomb friction compensation current computing means 4, viscous friction compensation current computing means 5, inertia compensation current computing means 6, steering force assist current computing means 7, and current control means 8. Reference numeral 9 represents the static friction computing means for computing an estimated value Tf of static friction of the steering system from a steering torque Vt from the torque sensor 14 (Step S5 in FIG. 4). Reference numeral 10 represents static friction compensation current computing means for computing a static friction compensation current If for compensating for the static friction of the steering system based on a static friction estimated value Tf from the static friction computing means 9 and a car speed Vs obtained from the output of the car speed sensor 13 (Step S10 in FIG. 4). See page 12, lines 14-32; page 13, lines 30-34; and page 15, lines 1-6.

VI. <u>ISSUES</u>

The sole issue on appeal is whether claims 1, 2, and 4-20 are properly rejected under 35 U.S.C. § 103(a) as being unpatentable over Kifuku et al. in view of Setaka et al.

VII. GROUPING OF CLAIMS

For the purposes of the present appeal, the rejected claims do not stand or fall together. Specifically, the rejected claims are divided into the following separately patentable groups.

Group 1:	Claims 1, 5, 6, 18, 19, and 20
Group 2:	Claims 2 and 8
Group 3:	Claim 4
Group 4:	Claim 7
Group 5:	Claims 9, 10, and 14
Group 6:	Claims 11, 12, 13, 15, 16, and 17

The Arguments section below provides arguments in support of the separate patentability of the groups, beginning on the following pages: Group 2, page 8; Group 3, page 8; Group 4, page 9; Group 5, page 10; Group 6, page 11.

VIII. ARGUMENTS

Appellants respectfully submit that the claims are not obvious over Kifuku et al. in view of Setaka et al.

Group 1

Group 1 includes claims 1, 5, 6, 18, 19, and 20. Claim 1 is independent, and claims 5 and 18 depend from claim 1. Claim 6 depends from claim 5, and claims 19 and 20 depend from claim 20.

Group 1, Argument 1: Kifuku et al. and Setaka et al. fail to teach or suggest a means of computing an estimated value of static friction of the steering system based on the steering force of a driver.

Independent claim 1 requires "a means of computing an estimated value of static friction of the steering system based on the steering force of a driver." The Examiner concedes that Kifuku et al. do not disclose this limitation of the claim, but asserts that Setaka et al. disclose the limitation. See page 2 of the July 17, 2002 Office Action. Appellant respectfully disagrees, as set forth below.

Setaka et al. relates to a torque detection apparatus for measuring a torque applied between a drive shaft and an output shaft, which is applicable to an electric power steering system of a motor vehicle. The excerpt cited by the Examiner (col. 2, lines 12-15) simply states that it is "an object of the present invention to provide a torque detection apparatus which is capable of accurately detecting both rotational and static torques concurrently with apparatus size-reduction." However, neither this excerpt, nor any other part of Setaka et al., discloses or suggests a means of computing an estimated value of static friction of the steering system based on the steering force of a driver, as required by claim 1 of the present invention. Instead, Setaka et al. state that "the torque detection apparatus according to the present invention is arranged so as to form two magnetic circuits and to measure the torque between the first and second shafts on the basis of the difference of the magnetic fluxes flowing through the first and second magnetic circuits." Col. 3, lines 6-11. Thus, Setaka et al., like Kifuku et al., fail to teach or suggest the aforementioned limitation of independent claim 1.

The Examiner asserts in the "Response to Arguments" of the July 17, 2002 Office Action that Setaka et al. disclose this feature of claim 1 of the present invention, because the reference discloses a torque sensor that measures static and rotational torque. On this point, Appellant submits that the torque sensor of Setaka et al. does not correspond to the means of computing an estimated value of static friction of the steering system based on the steering force of a driver, as described above. Furthermore, the Examiner has not provided any reasoning to support his assertion. Thus, the applied references fail to teach or suggest all of the limitations of claim 1.

Therefore, Appellant respectfully requests the reversal of the rejection of the claims of Group 1, for at least the aforementioned reasons.

Group 1, Argument 2: There is no motivation or suggestion to combine Kifuku et al. and Setaka et al.

Appellant submits that there is no motivation or suggestion to combine the references. Kifuku et al. provide a means for compensating for static friction of a steering system, but static friction compensation of Kifuku et al. differs from that of the present invention, as described below.

FIG. 31 of the reference, as well as the description at column 20, lines 34-39, which represents static friction compensation in the reference, clearly shows a static-friction compensating current calculation means 20 for compensating the static friction based on the estimated value of the static friction that uses vehicle speed Vs and a differentiated value of motor angular velocity ω as inputs to produce a static-friction compensating current target If. In other words, Kifuku et al. teach a technology of computation of steering assist current target

value Is based on a differentiated value of motor angular velocity and vehicle speed Vs, and does not teach or suggest a means for obtaining static friction of the steering system based on a driver's steering force (steering torque Vt). Moreover, the static friction compensating current calculation means 20 of Kifuku et al. uses a differentiated value of motor angular velocity ω. By contrast, the static friction compensation current computing means 10 of the present invention estimates the value of static friction of the steering system independently of the motor angular velocity ω.

With regard to the Examiner's assertion that "[o]ne of ordinary skill in the art would have been motivated to use the smaller and improved torque sensor of Setaka et al." in the system of Kifuku et al., Appellant submits that there is no indication in Setaka et al. of whether or not the torque sensor of Setaka et al. is smaller or improved over the torque sensor of Kifuku et al. For example, nothing in Setaka et al. indicates the size of the torque sensor. That the Setaka et al. reference discusses an intent to reduce the size of the apparatus (col. 2, line 15) does not teach any quantitative parameter that would allow for a determination of a particular size. Thus, the Examiner's assertion is unsupported.

Thus, Kifuku et al. disclose its own static friction compensation, and there is no support for the assertion of a motivation to combine the teachings of Setaka et al. with Kifuku et al. Therefore, one of ordinary skill in the art would not have been motivated to combine the alleged static friction teachings of Setaka et al. with Kifuku et al.

Appellant respectfully requests the reversal of the rejection of the claims of Group 1 for this additional reason also.

Group 2

Group 2 includes claims 2 and 8. Claim 2 depends from claim 1, and claim 8 depends from claim 2.

Group 2, Argument 1: Kifuku et al. and Setaka et al. do not teach or suggest the static friction of the steering system being estimated by extracting the edge of the steering force detection value.

The Examiner asserts that Kifuku et al. disclose the limitations of claim 2 at col. 20, lines 45-46, but Appellant disagrees. Col. 20, lines 45-46 of Kifuku et al. disclose that the differential calculation means 19 differentiates the motor angular velocity estimate ω and extracts the rising edge ω_{edg}. Thus, the excerpt of Kifuku et al. referred to by the Examiner discusses only a motor angular velocity estimate and does not state anything about estimating the static friction of the steering system by extracting the edge of the steering force detection value. Moreover, Setaka et al. do not make up for this deficiency of Kifuku et al.

Appellant respectfully requests the reversal of the rejection of the claims of Group 2, for at least the reasons noted with respect to claim 2 and the reasons noted above with respect to Group 1.

Group 3

Group 3 includes claim 4, which depends from claim 1.

Group 3, Argument 1: Kifuku et al. and Setaka et al. do not teach or suggest the static friction of the steering system being estimated by extracting the edge of a motor current.

Claim 4 recites estimation of the static friction by extracting the edge of a motor current. In contrast, the portion of Kifuku et al. cited by the Examiner (col. 21, lines 25-28) discusses obtaining the edge by processing the Coulomb-friction compensating current target I_c in differential calculation means 19, as illustrated in Figure 34. As explained in the present application on page 18, lines 6-9, the motor current encompasses a motor detection current I_m and a compensation current. However, Kifuku et al. obtain the edge only by processing the Coulomb-friction compensating current target I_c, as opposed to a motor current.

Appellant submits that Setaka et al. also fail to teach or suggest the limitations of claim 4.

Appellant respectfully requests the reversal of the rejection of claim 4, for at least the reasons noted with respect to claim 4 and the reasons noted above with respect to Group 1.

Group 4

Group 4 includes claim 7, which depends from claim 1.

Group 4, Argument 1: Kifuku et al. and Setaka et al. do not teach or suggest the static friction of the steering system being estimated by extracting an edge of the steering force detection value, the motor angular velocity, the motor back electromotive force, the steering angular velocity or the motor current, and the static friction of the steering system being estimated by multiplying an extracted value of the edge by a predetermined function of motor angular velocity, motor back electromotive force or steering angular velocity.

Kifuku et al. fail to teach or suggest estimating the static friction of the steering system by multiplying an extracted value of the edge by a predetermined function, as recited by claim 7. Instead, the reference uses ω_{edg} and the vehicle speed V_s in accordance with a look up table of static friction compensating current values, to determine the compensating current target I_f. See

col. 20, lines 46-52. In particular the portion of Kifuku et al. on which the Examiner relies for this feature, namely col. 20, lines 33-39, discusses a differential value of the motor angular velocity estimate ω, but makes no mention of estimating the static friction of the steering system by multiplying an extracted value of the edge by a predetermined function, as recited by claim 7. Setaka et al. do not make up for this deficiency of Kifuku et al.

Appellant respectfully requests the reversal of the rejection of claim 7, for at least the reasons noted with respect to claim 7 and the reasons noted above with respect to Group 1.

Group 5

Group 5 includes claims 9, 10, and 14. Claim 9 depends from claim 1. Claims 10 and 14 depend from claim 9.

Group 5, Argument 1: Kifuku et al. and Setaka et al. do not teach or suggest the static friction compensation having a term proportional to the static friction estimated value obtained by the positive feedback of the static friction estimated value is computed and the static friction of the steering system is compensated by the static friction compensation.

According to claim 9, the static friction of the steering system is compensated by a static friction compensation having a term proportional to the static friction estimated value. An example of such a proportional term is the first term in equation 4 on page 15 of the present application. In contrast, Kifuku et al. disclose using ω_{edg} and the vehicle speed V_s in accordance with a look up table of static friction compensating current values, to determine the compensating current target I_c. See col. 20, lines 46-52. As shown in Figure 33, the resulting

compensating current target I_c has only certain constant values, and does not have a term proportional to a static friction estimated value.

Also, Appellant submits that Setaka et al. do not make up for this deficiency of Kifuku et al.

Appellant respectfully requests the reversal of the rejection of the claims of Group 5, for at least the reasons noted with respect to claim 9 and the reasons noted above with respect to Group 1.

Group 6

Group 6 includes claims 11, 12, 13, 15, 16, and 17. Claims 11, 13, 15, and 16 depend from claim 1, claim 12 depends from claim 11, and claim 17 depends from claim 16.

Group 6, Argument 1: Kifuku et al. and Setaka et al. do not teach or suggest static friction compensation obtained through the means of compensating for the static friction being obtained from both a term proportional to the static friction estimated value and a term for compensating for the nonlinearity of the motor or a motor reduction gear.

Kifuku et al. neither teach nor suggest a term for compensating for the nonlinearity of the motor or a motor reduction gear, as recited by claims 11, 13, 15, and 16. An example of this later term can be found in the second term of equation 4 on page 15 of the present application. Neither the portion of Kifuku et al. cited by the Examiner (col. 20, lines 47-52) nor the cited Figure 33 teaches or suggests either of these terms. Kifuku et al. disclose using ω_{edg} and the vehicle speed V_s in accordance with a look up table of static friction compensating current values, to determine the compensating current target I_c. See col. 20, lines 46-52. As shown in

Figure 33, the resulting compensating current target I_c has only certain constant values, and does not have a term for compensating for the nonlinearity of the motor or a motor reduction gear.

Furthermore, Setaka et al. fail to teach or suggest the limitations of claims 11, 13, 15, and 16.

Appellant respectfully requests the reversal of the rejection of the claims of Group 6, for at least the reasons noted with respect to claims 11, 13, 15, and 16 and the reasons noted above with respect to Group 1.

IX. CONCLUSION

Appellant respectfully requests the members of the Board to reverse the rejection of all appealed claims and to find each of the claims allowable as defining subject matter which is patentable over the applied reference.

The present Brief on Appeal is being filed in triplicate. Unless a check is submitted herewith for the fee required under 37 C.F.R. §1.192(a) and 1.17(c), please charge said fee to Deposit Account No. 19-4880.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

Cameron W. Beddard
Registration No. 46,545

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON OFFICE

23373

PATENT TRADEMARK OFFICE

Date: June 2, 2003

APPENDIX

CLAIMS 1, 2, and 4-20 ON APPEAL:

1. An electric power steering system for driving a motor connected to a steering system based on a steering force detection value obtained by detecting the steering force of a driver to assist the steering force of the steering system, the system comprising:

a means of computing an estimated value of static friction of the steering system based on the steering force of a driver; and

a means of compensating for the static friction based on this estimated value of static friction.

2. The electric power steering system of claim 1, wherein the static friction of the steering system is estimated by extracting the edge of the steering force detection value.

4. The electric power steering system of claim 1, wherein the static friction of the steering system is estimated by extracting the edge of a motor current.

5. The electric power steering system of claim 1, wherein the static friction of the steering system is estimated by extracting an edge of the steering force detection value, the motor angular velocity, the motor back electromotive force, the steering angular velocity or the motor current, wherein the extraction of the edge is carried out through a high frequency pass filter.

6. The electric power steering system of claim 5, wherein the time constant of the high-frequency pass filter is made almost equal to the mechanical time constant or acceleration constant of the motor.

7. The electric power steering system of claim 1, wherein the static friction of the steering system is estimated by extracting an edge of the steering force detection value, the motor angular velocity, the motor back electromotive force, the steering angular velocity or the motor current, and the static friction of the steering system is estimated by multiplying an extracted value of the edge by a predetermined function of motor angular velocity, motor back electromotive force or steering angular velocity.

8. The electric power steering system of claim 2, wherein an upper limit is provided for the static friction estimated value.

9. The electric power steering system of claim 1, wherein static friction compensation having a term proportional to the static friction estimated value obtained by the positive feedback of the static friction estimated value is computed and the static friction of the steering system is compensated by the static friction compensation.

10. The electric power steering system of claim 9, wherein the gain of the positive feedback is set such that the static friction estimated value and the motor output torque become almost equal to each other.

11. The electric power steering system of claim 1, wherein static friction compensation obtained through the means of compensating for the static friction is obtained from both a term proportional to the static friction estimated value and a term for compensating for the nonlinearity of the motor or a motor reduction gear.

12. The electric power steering system of claim 11, wherein the term for compensating for the nonlinearity of the motor or the motor reduction gear is used when the static friction

estimated value is larger than a predetermined value.

13. The electric power steering system of claim 1, wherein the static friction is compensated by multiplying the term proportional to the static friction estimated value obtained through the means of computing the estimated value of the static friction by a predetermined function for compensating for the nonlinearity of the motor or the motor reduction gear.

14. The electric power steering system of claim 9, wherein an upper limit is provided for at least one or all of the static friction compensation performed through the means of compensating for the static friction, the term proportional to the static friction estimated value obtained through the means of computing the estimated value of the static friction and the term for compensating for the nonlinearity of the motor or the motor reduction gear.

15. The electric power steering system of claim 1, wherein the static friction is compensated by multiplying at least one or all of the static friction compensation performed through the means of compensating for the static friction, the term proportional to the static friction estimated value obtained through the means of computing the estimated value of the static friction, and the term for compensating for the nonlinearity of the motor or the motor reduction gear by a predetermined function of motor angular velocity, motor back electromotive force and steering angular velocity.

16. The electric power steering system of claim 1, wherein at least one or all of the static friction estimated value obtained through the means of computing an estimated value of the static friction, the static friction compensation performed through means of compensating for the static friction, the term proportional to the static friction estimated value obtained through the means of

computing the estimated value of the static friction and the term for compensating for the nonlinearity of the motor or the motor reduction gear are changed based on car speed or engine speed.

17. The electric power steering system of claim 16, wherein at least one or all of the function of motor angular velocity, motor back electromotive force or steering angular velocity, the positive feedback gain, the term for compensating for the nonlinearity of the motor or the motor reduction gear, the predetermined function for compensating for the nonlinearty of the motor or the motor reduction gear and the upper limit are changed based on car speed or engine speed.

18. The electric power steering system of claim 1, wherein the dynamic friction or inertia of the steering system is compensated based on the angular velocity or angular acceleration of the motor or steering.

19. The electric power steering system of claim 18, wherein a term for compensating for dynamic friction and a term for compensating for static friction are weighed so that one of them is used.

20. The electric power steering system of claim 18, wherein the term for compensating for dynamic friction, the term proportional to the static friction estimated value and the term for compensating for the nonlinearity of the motor or the motor reduction gear are weighed so that at least one of them is used.